

recognized. The string of characters is most typically a word, but might be a plurality of words making up a phrase. The string of characters are alphanumeric characters, and thus might be mixed as numbers and words in a phrase. While "word" will be used throughout to represent the character string being recognized, it should be understood that the character string might be a mix of alphanumeric characters, a plurality of words, or a phrase.

Please replace the paragraph beginning on page 6, line 25 and ending on page 7, line 2 with the following paragraph:

Device 200 may also have input device(s) 214 such as keyboard, mouse, pen, voice input device, touch screen input device, document scanners, etc. Output device(s) 216 such as a display, speakers, printer, electro-mechanical devices, such as document handlers, controlled by device 200, may also be included. All these devices are well known in the art and need not be discussed at length here. The particular input/output device working with the computing device 200 will depend on the application in which the recognition system is working and whether the recognition system is working offline or online with cursive images being recognized.

Please replace the paragraph beginning on page 7, line 3 and ending on page 7, line 16 with the following paragraph:

With the computing environment in mind, another embodiment of the invention is shown in FIG. 3. In this embodiment, the combined holistic-analytic recognition technique is divided into a holistic phase, a segmentation phase, an analytic phase and a merge phase. Again, an image of a word is loaded into the computing system by the load operation 302. The image might be loaded by scanning a handwritten document or by detecting a word entered on a touch screen with a stylus. The load operation 302 digitizes the cursive word image and passes it to the identify features module 304 and to the translate module 306. The identify features module 304 breaks the word image into character features, i.e. portions of a character that may be used to recognize the word. Accordingly, the output of the identify features module 304 is a string of character features for the entire

word, or in the case of the Guberman et al patent, a string of metastrokes.

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5 Another output from the identify features module 304 is the position of each feature relative to the word image. In the example of metastrokes, the features list 312 would contain, for the input word image, the string of metastrokes for the input word and the position of the metastrokes along the digitized image of the word.

Please replace the paragraph beginning on page 7, line 17 and ending on page 7, line 27 with the following paragraph:

10 In the matching operation 308 the string of input character features from feature list 312 is matched against prototype features for words in a vocabulary provided by a lexicon of words 310. Lexicon, or dictionary, 310 may be tailored to an expected vocabulary for the input words to be recognized. The words in the lexicon are stored in ASCII character form. The words in ASCII character form from lexicon 310 are converted by convert operation 309 into a string of
15 prototype character features. A plurality of sets of prototype character features for various shapes of each ASCII character is stored as prototype character features 307. Convert operation 309 retrieves one or more prototype character feature sets for each character in a word from lexicon 310 and passes the string of prototype character features for the reference word to the matching operation 308.
20 If the character features are metastrokes, a prototype string of metastrokes is then compared against the input string of metastrokes received from identify operation 304 for the input word.

Please replace the paragraph beginning on page 8, line 4 and ending on page 8, line 16 with the following paragraph:

25 After the matching operation for each answer, it is possible to construct a character segmented feature list. The constructing operation includes a back track operation 313 and a locate operation 314. The back track operation 313 traces back through the decision operations performed by matching operation 308 in matching the strings of metastrokes. As the decisions are traced, back track
30 operation 313 associates each input metastroke with a corresponding prototype

metastroke. The decision operations may be graphed as a matching path through a matching graph matrix where as in the Guberman et. al patent, the matching graph ordinates are the prototype metastrokes and the input metastrokes. This matching technique and the matching graph is also described in an article entitled

5 "Handwritten Word Recognition - The Approach Proved by Practice" by G. Dzuba, A. Filatov, D. Gershuny, and I. Kil, (Proceedings IWFHR-VI, August 12-14, 1998, Taejon, Korea, pp. 99-111. A matching decision, which moves the recognition process forward in the matching graph, is a move diagonally through the graph. Each of these diagonal moves effectively identifies a correspondence

10 ~~between an input metastroke and a prototype metastroke.~~

Please replace the paragraph beginning on page 8, line 17 and ending on page 8, line 24 with the following paragraph:

Locate operation 314 then locates the character segmentation points between input metastrokes from the correspondence of the input and prototype

15 metastrokes. Since the character segmentation locations between metastrokes are known for the string of prototype metastrokes, this information is applied to the correspondence between the input and prototype metastrokes to detect the segmentation points in the string of input metastrokes. Thus, the output of the locate operation 314 is the character segmented feature list 316 which has a string

20 of character features for each answer in the holistic answer list 311, and features are segmented into character sets for each character in the answer.

Please replace the paragraph beginning on page 11, line 10 and ending on page 11, line 17 with the following paragraph:

FIG. 6 illustrates an alternative embodiment for finding the best answer. In FIG.

25 6 the operations begin at retrieve operation 602 and retrieve operation 604. Retrieve operation 602 retrieves the best analytic answer from the analytic answer list 108 (FIG. 1) or 328 (FIG.3). The best answer on each list will be the answer with the highest confidence value. Retrieve operation 604 retrieves the best holistic answer from the holistic answer list 106 (FIG. 1) or 311 (FIG. 3). The

30 best analytic answer and the best holistic answer are passed to select operation

606. Select operation 606 uses any well known probability algorithm to choose the analytic or holistic answer as the best answer 608. The best answer plus its confidence 608 is the result of the select operation 606.

Please replace the paragraph beginning on page 12, line 18 and ending on page 12, line 27 with the following paragraph:

FIG. 8 illustrates an operational flow for another embodiment for the analytical recognition module 320 in FIG. 3. In FIG. 8, neural character recognition recognizes all possible character variants for all possible segmentation hypothesis based on the cutout images of character segmented words 318. In effect all possible ASCII words (legitimate or otherwise) are collected in candidate ASCII words list 804. When test operation 806 detects that all possible character variants for all possible segmentation hypotheses have been recognized, then word filter 808 operates to select legitimate word answers. Filter 808 uses the vocabulary dictionary 810 to pass to the analytic ASCII word answer list 328 only those candidate words from list 804 that have a counterpart word in the vocabulary dictionary 810. Again the confidence value is determined in the same manner as just discussed above for FIG. 7.

Please replace the paragraph beginning on page 3, line 1 and ending on page 3, line 9 with the following paragraph:

The invention may be implemented as a computer process, a computing system or as an article of manufacture such as a computer program product or computer readable media. The computer program product or computer readable media may be a computer storage medium readable by a computer system and encoding a computer program of instructions for executing a computer process. The computer program product or computer readable media may also be a propagated signal on a carrier readable by a computing system and encoding a computer program of instructions for executing a computer process.

Please replace the paragraph beginning on page 6, line 25 and ending on page 7, line 2 with the following paragraph:

Device 200 may also have input device(s) 214 such as keyboard, mouse, pen, voice input device, touch screen input device, document scanners etc. Output device(s) 216 such as a display, speakers, printer, electro-mechanical devices, such as document handlers, controlled by device 200, may also be included. All these devices are well known in the art and need not be discussed at length here. The particular input/output device working with the computing device 200 will depend on the application in which the recognition system is working and whether the recognition system is working offline or online with cursive images being recognized.

Please replace the paragraph beginning on page 10, line 12 and ending on page 10, line 20 with the following paragraph:

Fill detect operation 408 detects segmentation points between characters by detecting the point at which filling between metastroke features meets for those adjacent features from adjacent segmented feature sets. In other words, if two adjacent metastrokes are located in different character metastroke sets, then the meeting point for filling the digitized image between those adjacent metastrokes will be detected as a segmentation point between the characters represented by the metastroke sets. After each of these segmentation points is determined between the character feature sets, segment operation 410 cuts the word image at each of the segmentation points. Cutting the word image at the segmentation points provides the character cutout images 318 used in analytic recognition phase for the word. This completes the operations of the translate module 306 in FIG. 3.

Please replace the paragraph beginning on page 10, line 21 and ending on page 10, line 30 with the following paragraph:

FIG. 5 illustrates one embodiment for the find operation 110 or the merge or best answer phase in FIG. 3. In FIG. 5, the best answer operations begin at operation 502 which compares answers from the analytic answer list and the holistic answer list to find matches. When the same answer is on both lists, list operation 504 lists the matching answers with a combined value for their confidence. The combined value might simply be the average of the two confidence values. Alternatively the confidence in answers on each list might be weighted and